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Liming Acid Soils of Hawaii

N. V. Hue and H. Ikawa—Department of Agronomy and Soil Science

The infertility and toxicity of acid soils often restrict crop growth. Acid soils occur wherever rainfall is substantial. Soils also become acidified by repeated use of ammonium-producing fertilizers such as urea and diammonium phosphate. Acid soils of Hawaii include those classified as Oxisols, Ultisols, and the weathered Andisols (Table 1). Although acid soils are often defined as those with low pH (<6.0), problems with plant growth may result from other related factors, including H, Al, and/or Mn toxicities and Ca, Mo, and/or P deficiencies. These limiting factors must be corrected to improve plant growth, and this is often done by liming.

The practical question is, "How much lime ($CaCO_3$) must be added to make a soil less acid or to raise pH to a certain level, say 6.0?" Soils differ in their properties and chemical reactions and hence have different lime requirements. Rather than determine the lime requirement of every acid soil, we can infer a requirement from that of a similar soil.

To obtain the lime requirement curves graphed in Figure 1, we incubated soil samples with increasing amounts of $CaCO_3$ (equivalent to 0–8 tons/acre) at field moisture capacity and subjected them to at least two drying-wetting cycles to facilitate the reaction between the lime and the soil. After about two weeks, soil pH was measured (1:1 soil:water).

The use of liming curves is illustrated by the following examples. (1) You need to determine the amount of lime required to raise soil pH from 4.5 to 6.2 in the Paaloa soil. This soil's lime requirement curve is given in Figure 1 (graph 20), and it shows that 4 tons (8000 lb) of lime are needed per acre. (2) If the soil is not included in Figure 1, you may find a related soil in Table 1. For example, to find the lime requirement of the Akaka soil (a perudic Andisol), which is not found in Fig. 1, choose another perudic Andisol from Table 1, such as the Kaiwiki soil. Use its liming curve from Fig. 1. (3) If you don't know the soil series name or location, use the generalized lime requirement curve (graph 23) constructed from data for 22 soils; it is not exactly correct for any real soil, but it is useful (with caution!) for a first-approximation estimate. (4) If the initial soil pH is not on the generalized graph (e.g., it is 4.3 instead of 4.8, the lowest point on the curve), then draw a curve parallel to the one shown, starting at 4.3, and read the lime requirement from the newly drawn curve.

Table 1. Selected soils of Hawaii with similar characteristics in terms of lime requirement.

Soil order[1]	Moisture regime,[2] mineralogy[3]	Soll series
Oxisol	udic, oxidic	Halli, Kahanui, Kapaa, Mahana, Puhi
	ustic, kaolinitic	Lahaina, Lihue, Niu, Wahiawa
Ultisol	udic, oxidic (or ferritic)	Alaeloa, Hamakuapoko, Honolua, Kalapa, Kokee, Leilehua, Makawao, Manana, Paaloa, (Haiku)
	udic, kaolinitic	Kaneohe, Lolekaa, Waikane
Andisol	perudic	Akaka, Hilo, Kaiwiki, Piihonua
	udic	Kaipoioi, Maile,Olinda, Tantalus

[1]Oxisols are soils with low nutrient-holding capacity; Ultisols are soils with clay accumulation in the subsoil, with or without low nutrient-holding capacity; the Andisols listed are highly weathered volcanic ash soils.
[2]In the perudic soil moisture regime, annual rainfall exceeds evapotranspiration; the udic moisture regime is associated with soils that are moist most of the year; the ustic moisture regime is associated with semiarid soils.
[3]Soil iron content varies with mineralogy: ferritic > oxidic > kaolinitic.

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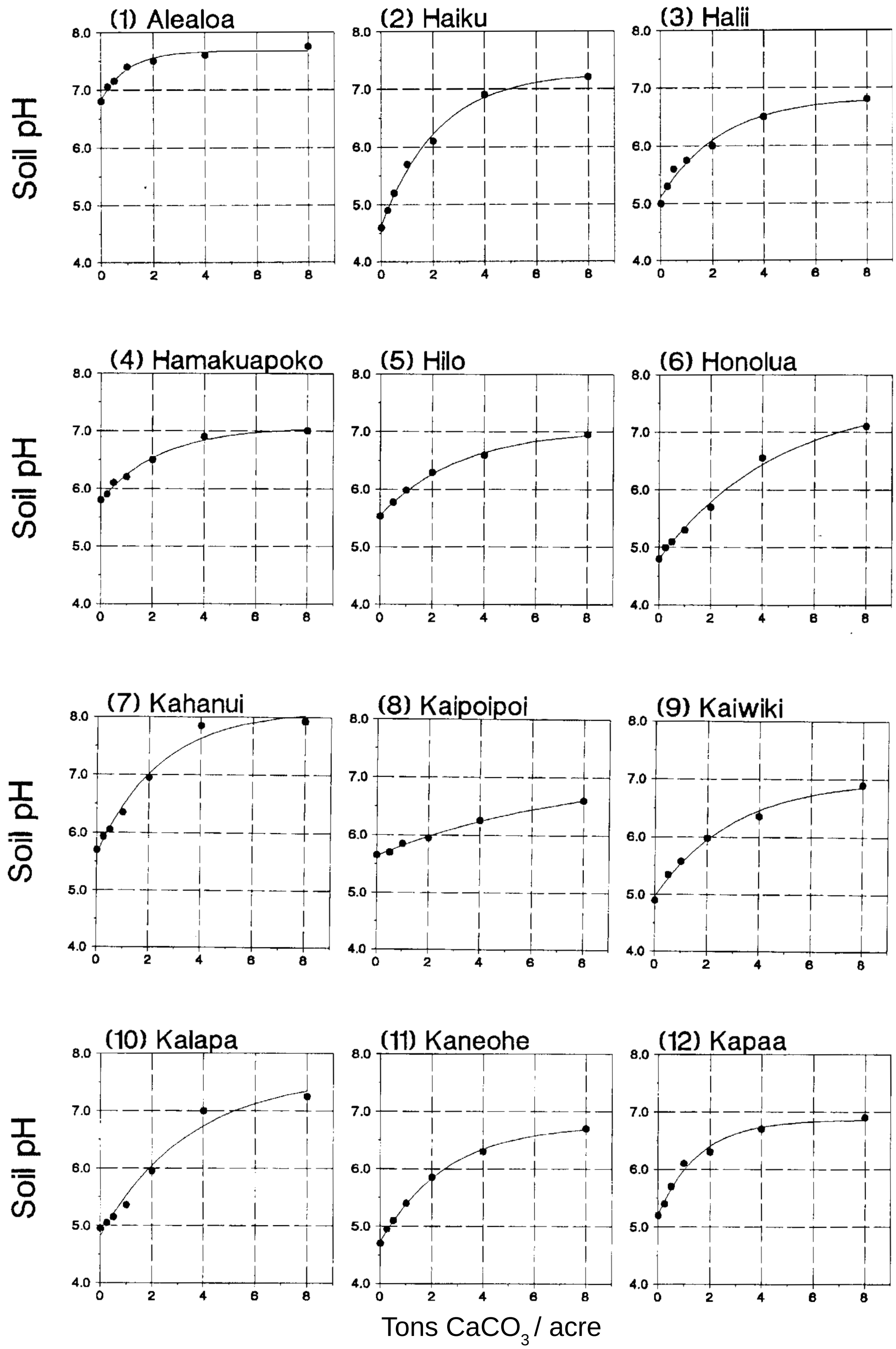
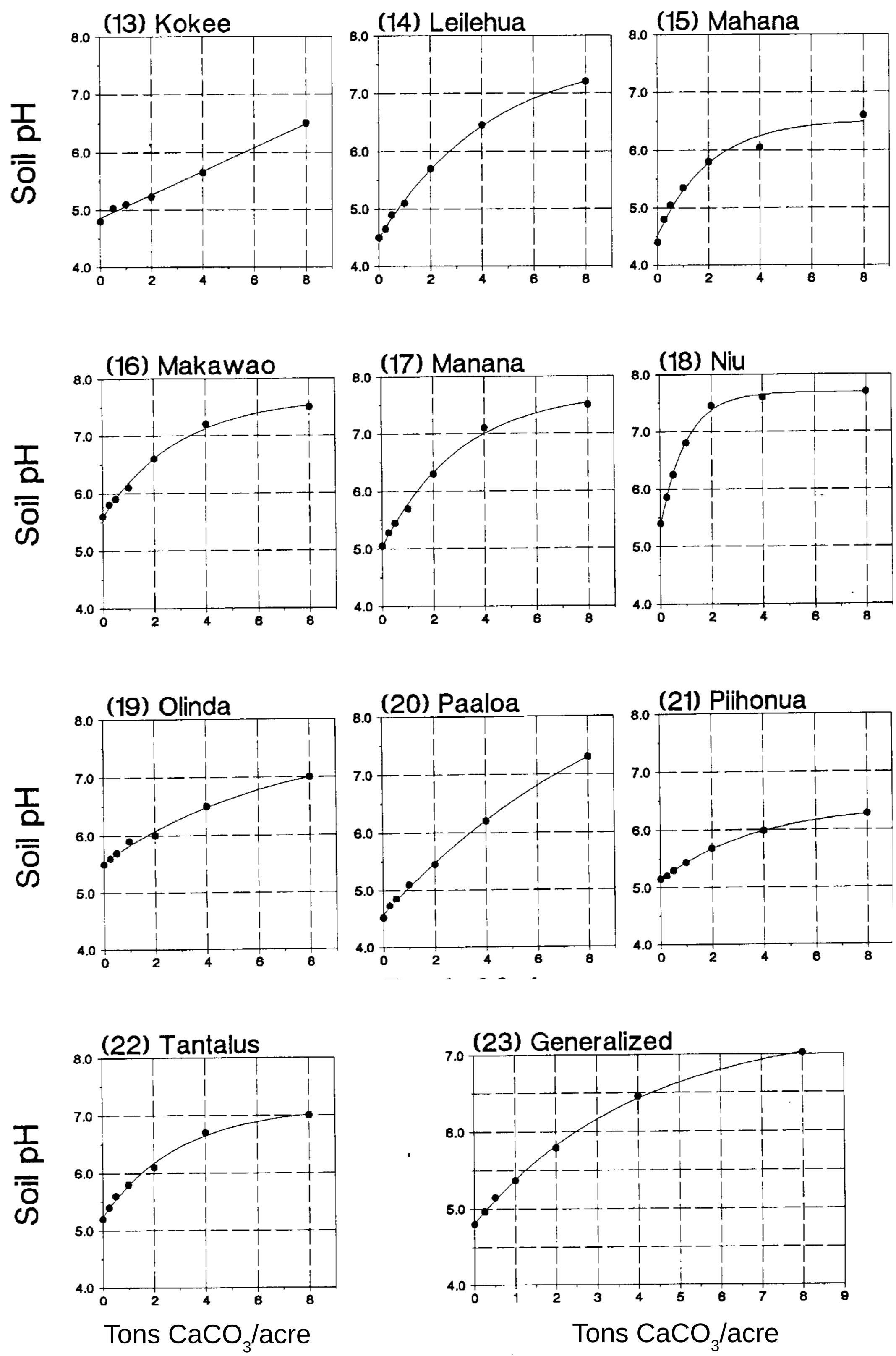
Figure 1. Lime requirement curves for selected soils of Hawaii.




(13) Kokee
(14) Leilehua
(15) Mahana
(16) Makawao
(17) Manana
(18) Niu
(19) Olinda
(20) Paaloa
(21) Piihonua
(22) Tantalus
(23) Generalized
Soil pH
Tons $CaCO_3$/acre